

Mixing and kneading

Machines for thermal processes with viscous, pasty and granular matter

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Solid products or high-molecular polymers are, till now, mainly processed in solution, suspension or emulsion because efficient heat- and mass transfer can be brought about by conventional reaction vessels. However, the increasing demand in chemical and related industries for saving energy, for simpler processes with elimination of solvent recovery steps and last but not least for environment-friendly operations, makes it desirable to process solid or viscous products in a concentrated form.

The fulfillment of the above demands require adequate equipment that combine the following main features:

- intensive mixing/kneading,
- large selfcleaning heat exchange surfaces for efficient process temperature control,
- large working volumes, which provide longer residence times for diffusion controlled processes,
- closed design to allow for vacuum operation and better pollution control.

The AP Conti (Fig. 1) and Discotherm B range of horizontal shaft mixers/kneaders are thermal processing units which fulfil the complex demands in this field where mechanical, thermal and chemical processes interface.

The AP-Conti can be operated with filling levels of 60 to 70% of its total free volume. It is manufactured with capacities in the range of 270 to 4 300 l corresponding to overall heat transfer surfaces of 6,1 m² to 40 m². Standard materials of construction are carbon and stainless steel. The housing and the shafts can be either heated or cooled according to the process requirements.

Complementary to the AP-Conti is the Discotherm B (DTB) Batch or Conti. It has a single shaft whose mixing elements intermesh with stationary kneading hooks, fixed along the housing of the equipment (Fig. 2).

The housing and the shaft, with its welded-on hollow disc segments, can be either heated or

cooled. The geometry of the internals assures a remarkably high thermal efficiency, particularly with products that tend to bake on.

At normal degree of filling of 60 to 80% of the total free volume there is enough disengagement space left for vapours or gases. Production equipment can be made from any weldable material in capacities up to 10 500 l for batch and 16 500 l for continuous units, with total heat transfer areas of up to 64 m² and 128 m² respectively.

For the treatment of highly viscous to solid matter relatively low agitator speeds ranging from 5 to 40 rpm are applied along with high available torque of up to max. 300 000 Nm for large units.

Different from other screw type equipment axial conveying and speed are independent from each other. This allows to control the average degree of filling mainly by the height of a overflow weir and to optimize heat- and mass transfer by increasing the speed. In continuous operation the disc segments limit backmixing, thus achieving narrow residence time distribution even at average residence times of up to several hours.

The operating flexibility of the Discotherm B makes it possible to transform in one-through process a liquid feed into a granular product. An interesting application demonstrating the versatile character of the Discotherm B machine is the Kolbe-Schmitt-process for the production of Na-Salicylate. This is a five step process that takes place in one single Discotherm B batch type reactor. The first step is the reaction of phenol with sodium hydroxide solution. An exothermic reaction demanding for good mixing of the reactants and for close temperature control. While the reaction is under progress water is formed, which is removed by simultaneous evaporation at atmospheric pressure. This leads to the crystallization of Na-phenolate (2nd process step) and eventually to its drying (3rd process step), the later under vacuum conditions, to a free flowing powder. The fourth process step is the carboxylation of Na-phenolate with CO₂ under elevated pressure. The yield of this gas-solid reaction depends on the close temperature control. This is a difficult task considering that the reaction mass goes through a pasty phase, where the efficient kneading action of Discotherm B is of major importance. Finally, the Na-Salicylate is dissolved in water. The application of the Discotherm B offers the following advantages:

- high specific capacity,
- very high yield and
- reduction of by-products by a factor of 10.

The second application, manifesting the advantages of the AP-Conti machine, is the recovery of TDI (toluene diisocyanate) from the residue stream of the TDI distillation. This stream with 50 wt.% TDI-content is processed under vacuum and high temperature to a residue material with less than 0,5 wt.% TDI-content. During this continuous operation the mass passes through a highly viscous state into a pasty transition phase before being discharged as a granulate.

The batch or continuous operation of these mixers, kneaders, dryers and reactors is supported by a set of auxiliary equipment.

Further information **c p p 203**

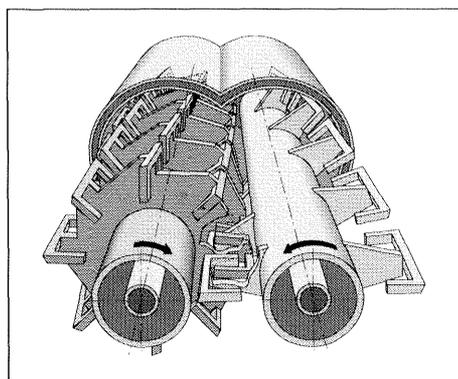


Fig. 1 AP-Conti twin shaft machine

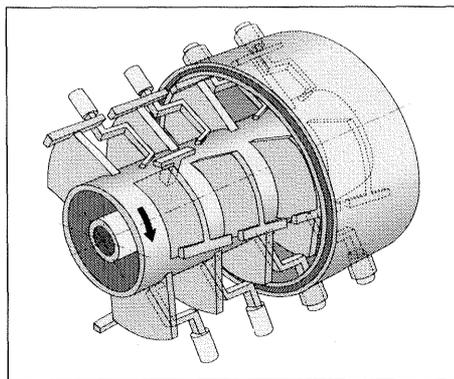


Fig. 2 Discotherm B machine